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Multichannel Kondo effect due to orbital dynamics of Cooper pair in unconventional superconductors

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The Kondo effect in unconventional superconductors is studied theoretically by using the Wilson's numerical renormalization group method. For the unconventional superconductors, the angular momentum of Cooper pair plays an important role in the Kondo effect. It produces multichannel exchange couplings with a local spin. Here we focus on a $p_x + ip_y$ -wave state which is a full gap system. We find that the ground state is always a spin doublet and the local spin cannot be quenched over all the T_K/Δ region, where T_K and Δ are the Kondo temperature and the superconducting energy gap, respectively. This is different from the s -wave pairing case where the Kondo singlet is realized for large T_K/Δ values. The strong coupling ($T_K/\Delta \rightarrow \infty$) analysis shows that the orbital dynamics of the $p_x + ip_y$ -wave Cooper pair destabilizes the Kondo singlet. On the other hand, the Kondo singlet is realized for a $d_{x^2-y^2}$ -wave in the large T_K/Δ region. As we argue in the $p_x + ip_y$ -wave and $d_{x^2-y^2}$ -wave cases, this type of multichannel Kondo effect reflects the symmetry of the conduction electron system.